(12) UK Patent Application (19) GB (11) 2 265 394 (13) A

(43) Date of A publication 29.09.1993

(21) Application No 9302546.8

(22) Date of filing 09.02.1993

(30) Priority data
(31) 4203740 (32) 09.02.1992 (33) DE

(71) Applicant
Dyckerhoff & Widmann Aktiengesellschaft

(Incorporated in the Federal Republic of Germany)

Erdinger Landstrasse 1, 8000 Munchen 81,
Federal Republic of Germany

(72) Inventors
Thomas Herbst
Harold Douglas Fines

(74) Agent and/or Address for Service
Boult Wade Tennant
27 Furnival Street, London, EC4A 1PQ,
United Kingdom

(51) INT CL[5]
D07B 5/00 7/18, E02D 5/80

(52) UK CL (Edition L)
D1T T1K T1M
E1D DPA
U1S S1571 S1702

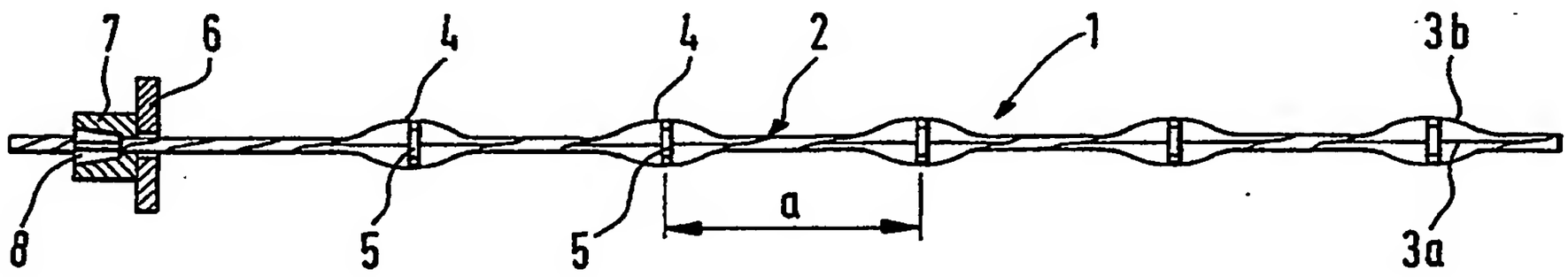
(56) Documents cited
GB 1135491 A GB 0290589 A

(58) Field of search
UK CL (Edition L) D1T, E1D DPA DRA
INT CL[5] D07B, E02D
Online databases: WPI

(54) Making an anchor element from a twisted steel wire strand

(57) A method and arrangement for manufacturing an anchor element 1, Fig 1a, from a strand 2 of steel wires 3 comprises spreading outer wires 3b, Fig 2a, of the strand apart from the central wire 3a to form expanded sections 4. For spreading apart the outer wires, the strand is axially advanced through a rotatably-mounted spreading disc 12 provided with a number of openings corresponding to the number of wires, wherein each individual wire is passed through one opening. Following the spreading disc 12 in the advancing direction, spacer elements 5 are mounted between the spread outer wires for fixing the outer wires in the spread position and forming the expanded sections. The spacer elements 5 can be mounted in a continuous operation independently of the length of the strand 2 and independently of whether the expanded sections are provided over the entire length, or only a part of the length, of the anchor element.

Fig. 1a



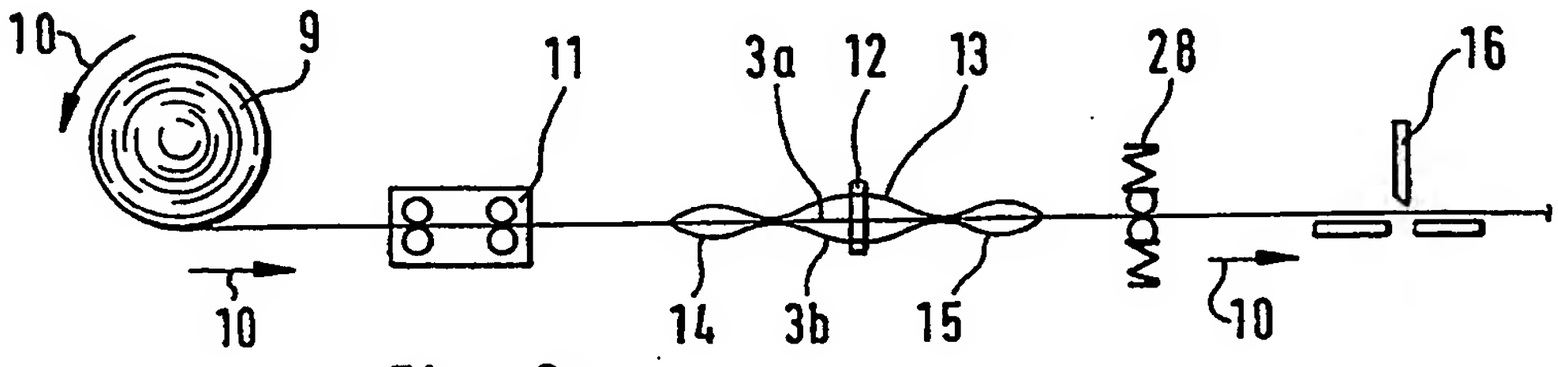


Fig. 2a

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 265 394 A

Fig. 1a

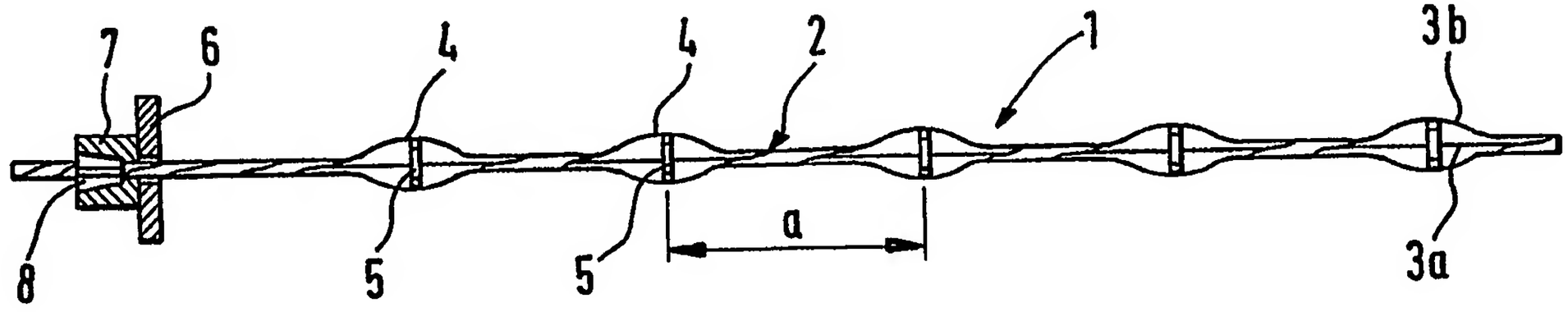
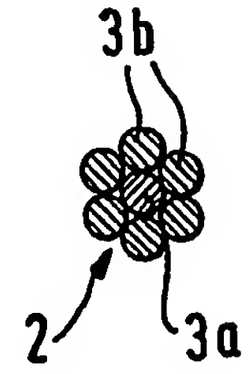


Fig. 1b



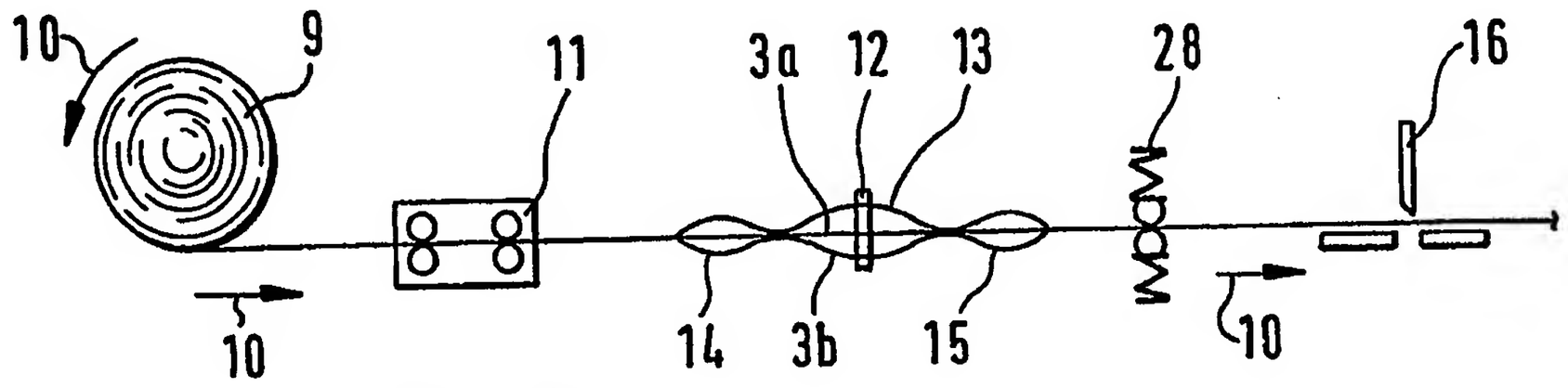


Fig. 2a

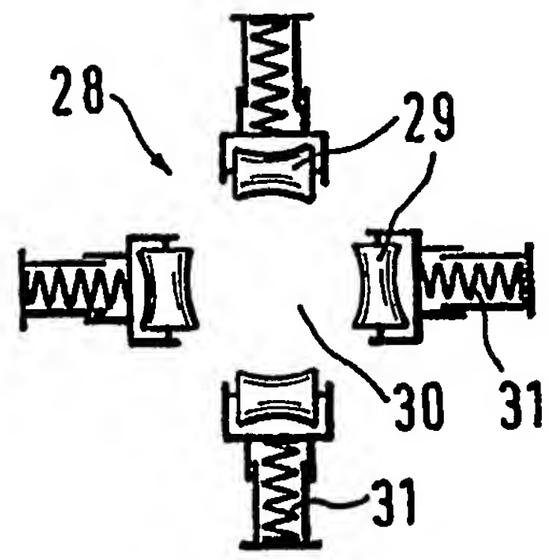


Fig. 6

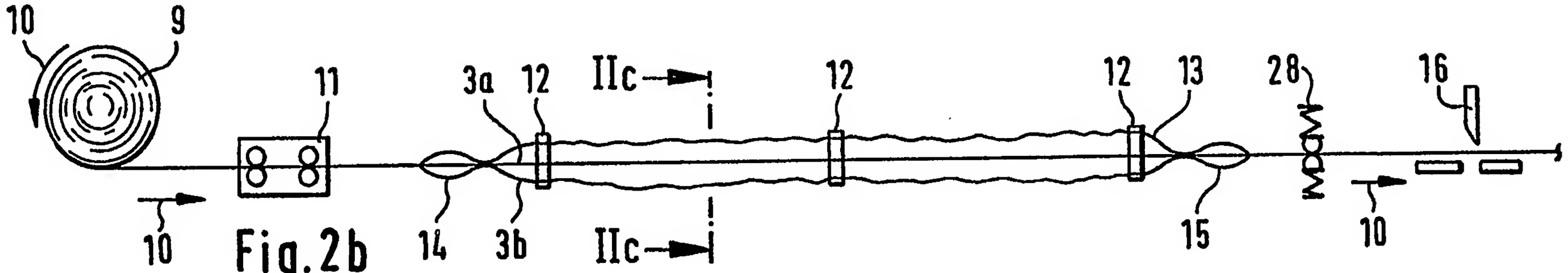


Fig. 2b

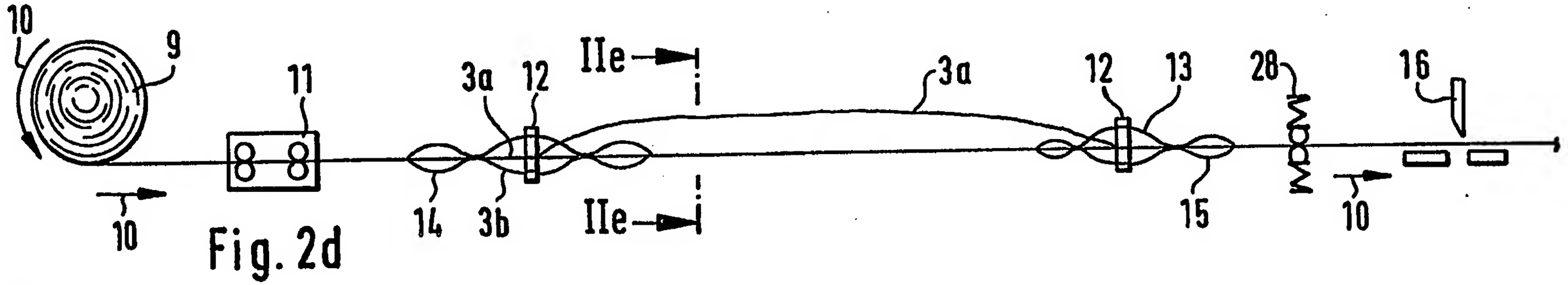


Fig. 2d

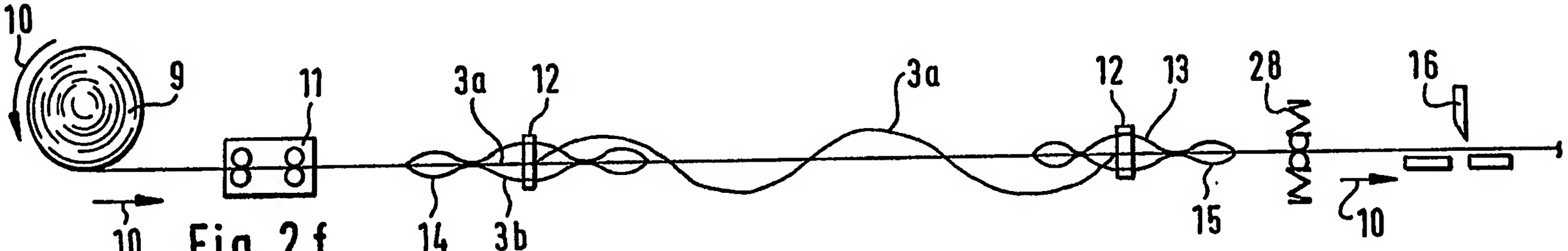


Fig. 2f

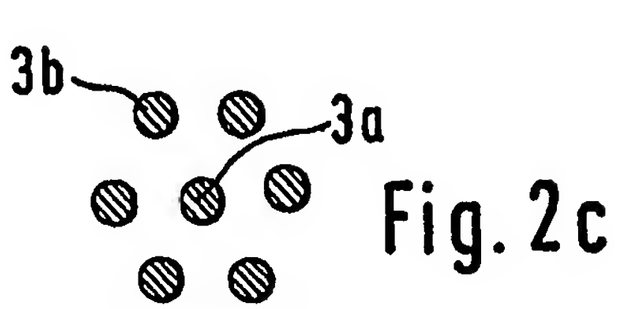


Fig. 2c

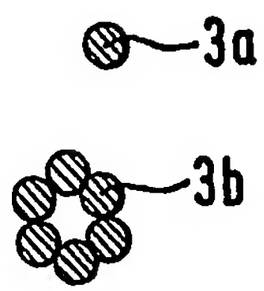


Fig. 2e

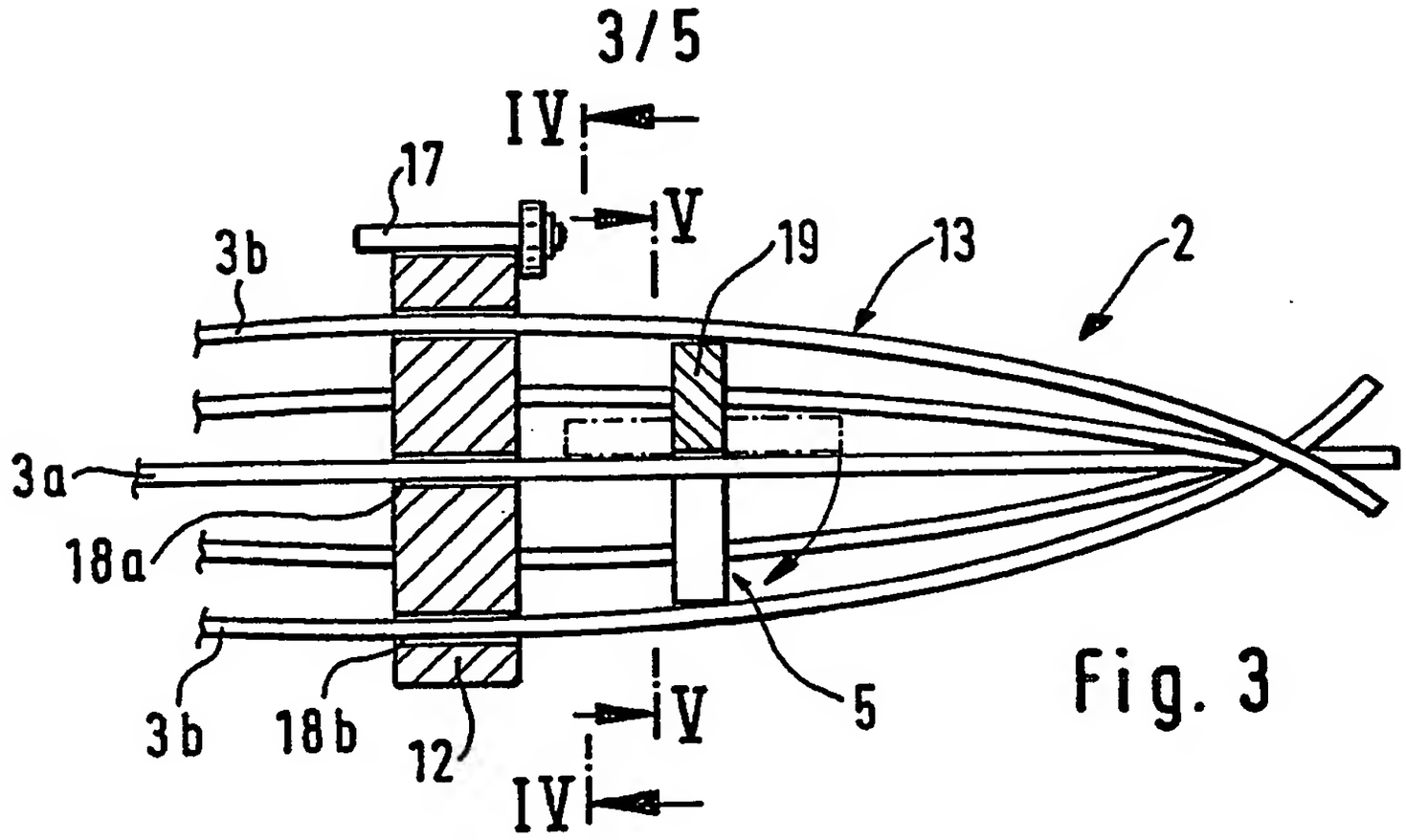


Fig. 3

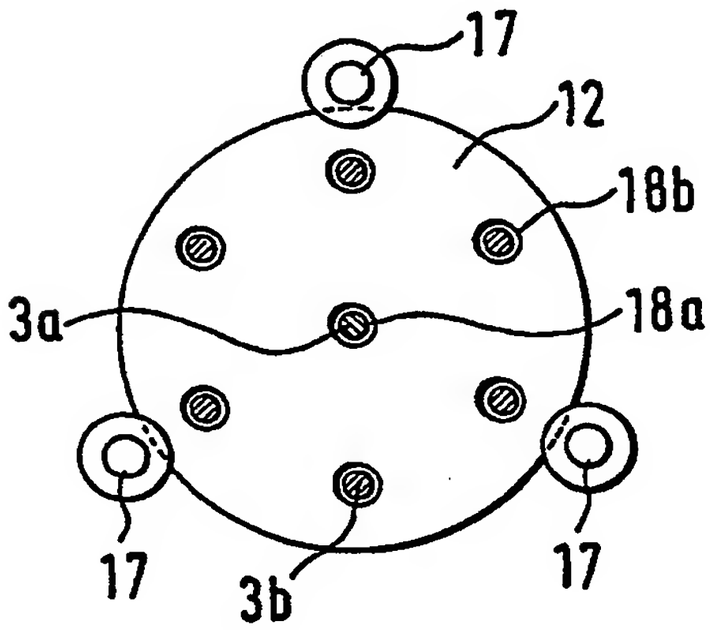


Fig. 4

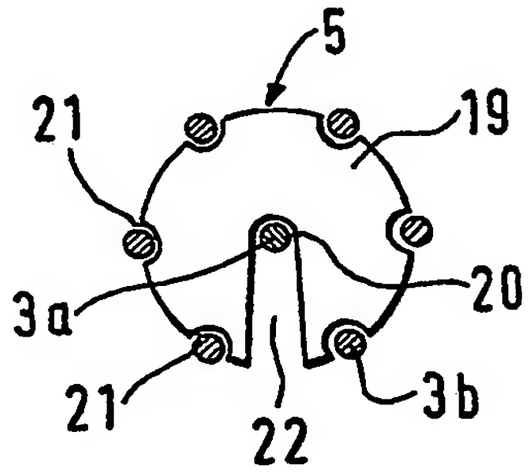


Fig. 5

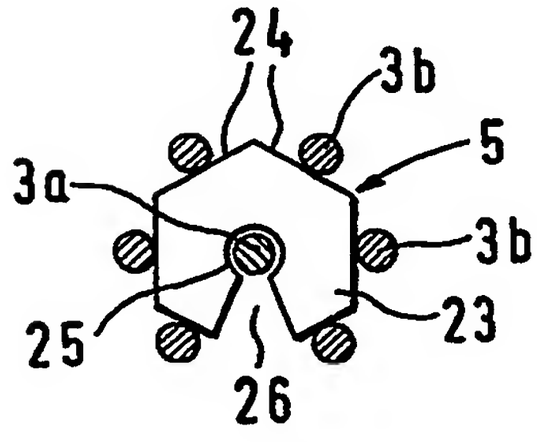


Fig. 7a

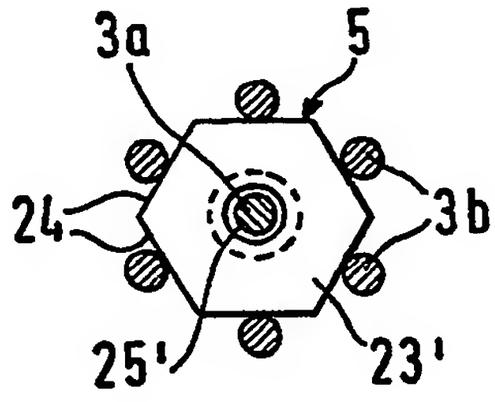


Fig. 7b

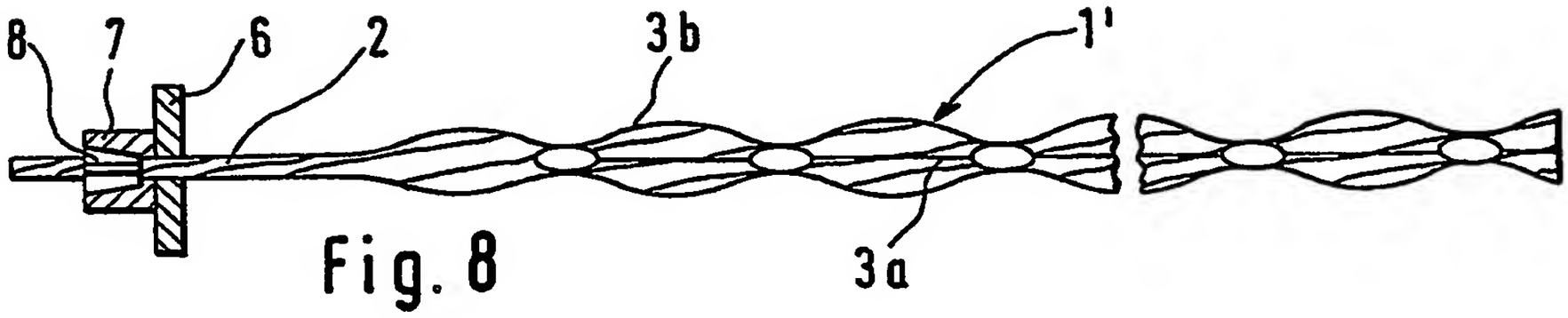


Fig. 8

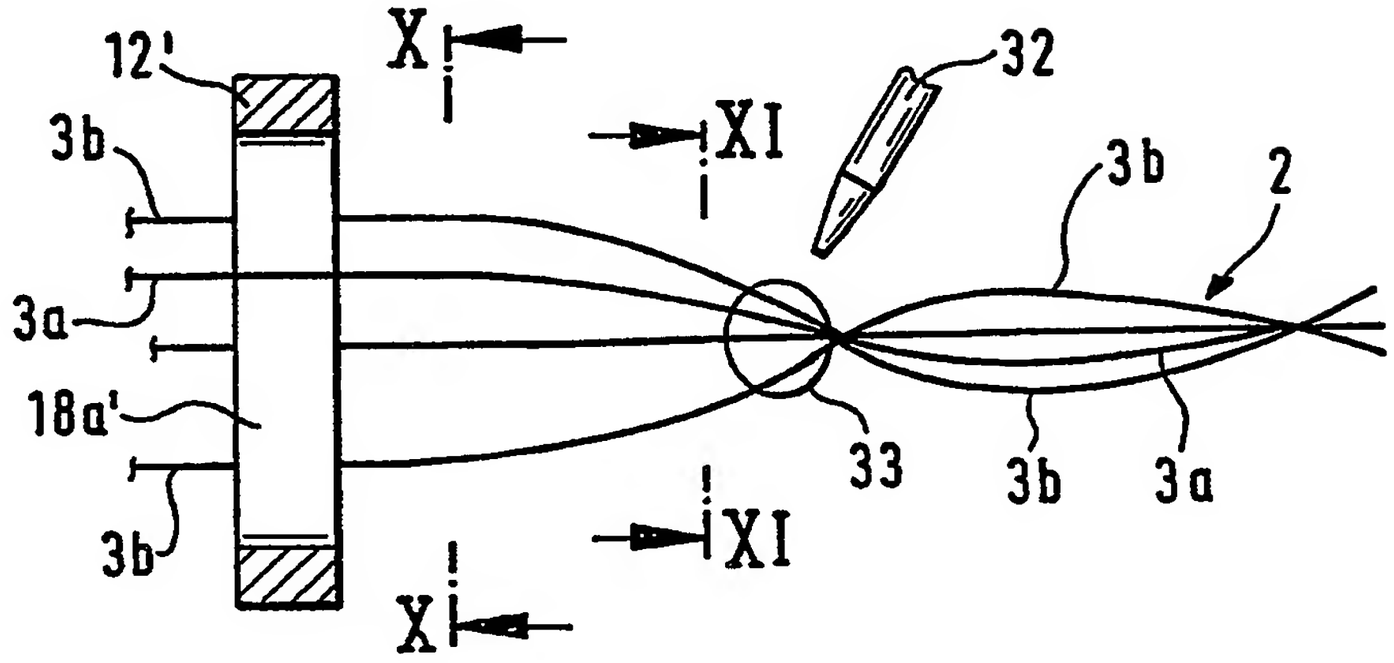
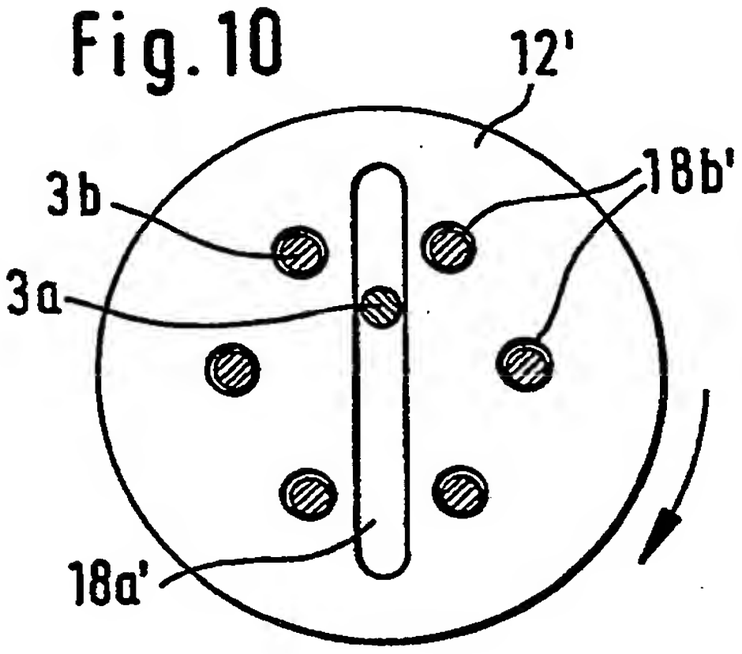


Fig. 9

Fig. 10



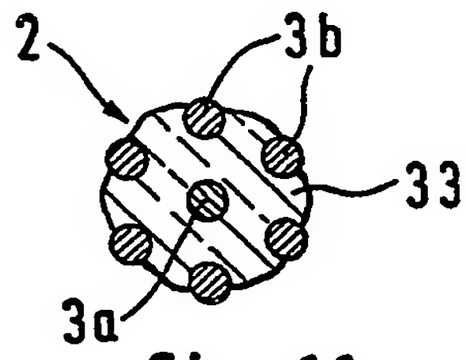


Fig. 11

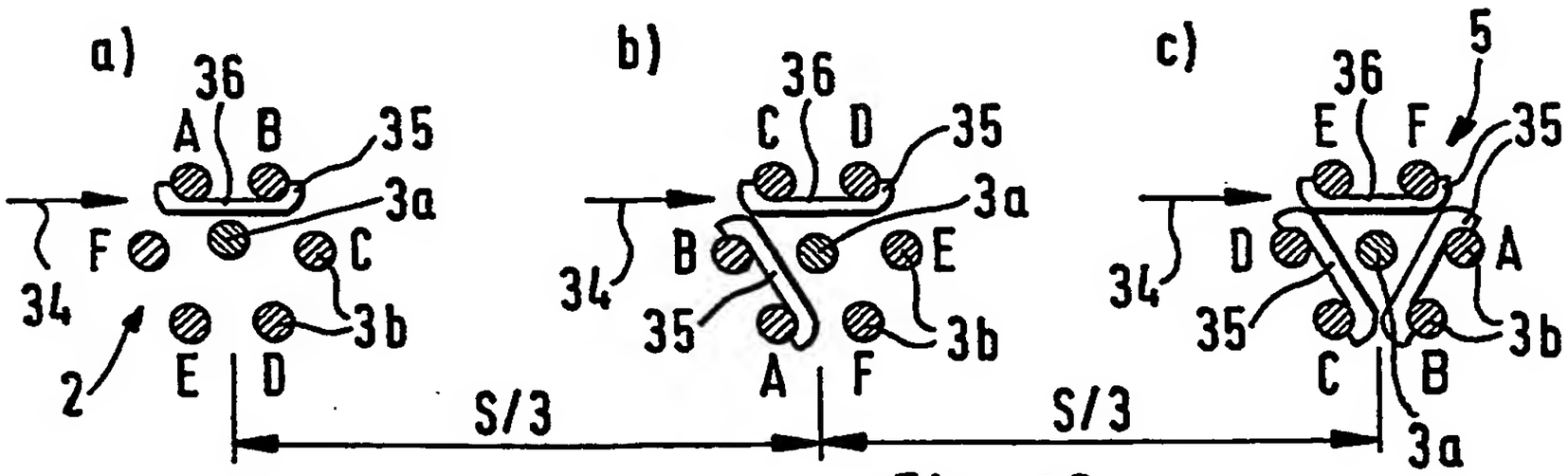


Fig. 12

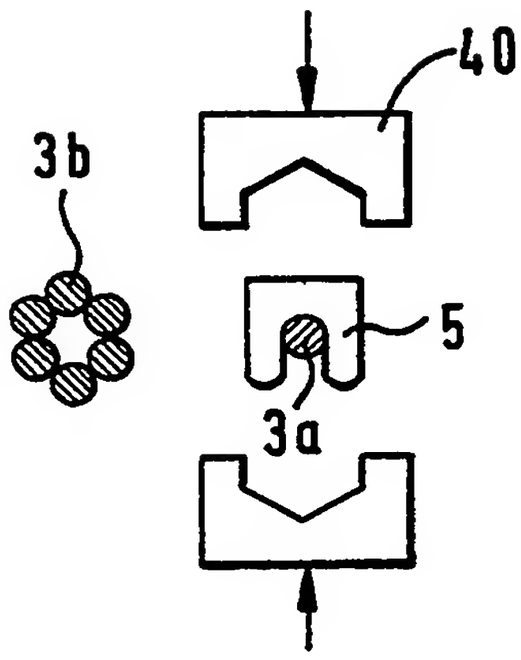


Fig. 13a

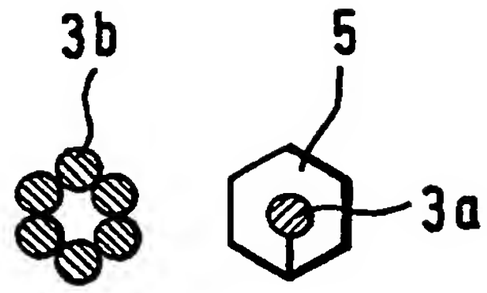


Fig. 13b

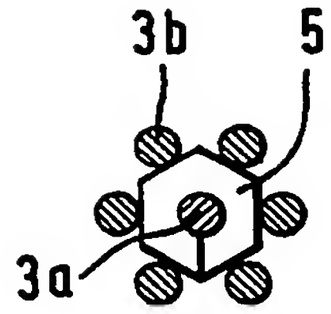


Fig. 13c

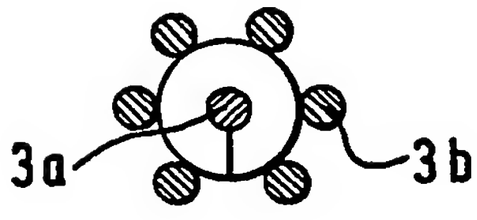


Fig. 13d

METHOD OF MANUFACTURING AN ANCHOR ELEMENT FROM A STRAND OF TWISTED STEEL WIRE

The present invention relates to a method of manufacturing an anchor element from a strand of twisted steel wire for use as a rock anchor or the like. The anchor element includes at least one expanded section obtained by spreading the individual wires of the strand.

The present invention further relates to an arrangement for spreading the individual wires of the strand, as well as to spacer elements for use in the method.

In mining, particularly coal mining, it is known to place rock bolts for securing underground cavities immediately after driving the cavity. Such rock bolts usually are composed of a rod-shaped anchor element of steel, for example, a steel rod, a steel pipe, or the like. The anchor element is inserted in a bore hole and a composite action between the anchor element and the rock is achieved by filling the bore hole with a hardening material, for example, cement mortar, synthetic resin, or the like.

Longer rock bolts of the above-described type cannot be used, or can only be used under great difficulties for longer bore holes, sometimes up to 15 m, because of the limited space available on location within narrow cavities. Accordingly, anchor elements of steel wire strands are also used as rock bolts. Steel wire strands are made from high-strength twisted steel wire, they are flexible within certain limits, and can be bent for inserting them within a bore hole. However, steel wire strands have a very smooth surface because of strain hardening during drawing, so that the forces resulting from composite action between the strands and the hardening material filling out the bore hole are frequently not sufficient for preventing the separation of layers in the rock formation.

In order to improve the composite action of wire ropes when used as rock anchors, it is already known to open a wire rope to the individual strands, to cut out the center strand, and to close the rope again with changed arrangement of the individual strands (CH-Z "Schweizerische Bauzeitung", 93rd Year, Volume 26, June 26, 1975, pp. 408-411). The purpose of this procedure is to facilitate penetration of mortar into the wire rope and to prevent contraction in transverse direction.

In steel wire strands, it is known in the art to provide expanded sections which are spaced apart from each other over the length of the strand and are produced by spreading apart the individual wires. The hardening material can penetrate into the expanded sections, so that the composite action is improved. In a method of the above-described type, the expanded sections are produced by opening the strand over its full length by inserting the individual wires in pipes, so that the individual wires are completely separated from each other. Subsequently, the wires are again twisted in a direction opposite to the original twisting direction (EP-B1 0 163 479). This procedure produces sections of increased diameter in which the wires are spaced apart from each other, which alternate with sections in which the wires are placed closely next to each other.

Finally, it is also known in the art to grasp a strand over the length thereof by means of clamping devices between the locations at which the expanded sections are to be produced and to move these clamping devices axially toward each other. This causes upsetting in axial direction and forms expanded sections in the areas between the clamping devices (WO 90/05811).

The known methods for improving the composite action of steel wire strands described above have the disadvantage that the diameter of the expanded sections cannot be defined precisely. However, it is desirable to maintain as uniform as possible a diameter of the strands in the areas of the expanded sections because the diameter of the bore holes must be kept as small as possible, so that the size of the drilling machines, the work required in drilling, and the consumption of hardening material can be reduced.

Therefore, it is the primary object of the present invention to provide in an anchor element of the above-described type a possibility for defining and maintaining as precisely as possible the diameters of the individual expanded sections in a simple and economical manner.

In accordance with the method of the present invention, for spreading apart the individual wires, the strand is moved in axial direction through at least one rotatably mounted spreading disc which has a number of openings corresponding to the number of individual wires, wherein each individual wire passes through an opening. In the portions in which the individual wires are spread apart in this manner, spacer elements are mounted for fixing the individual wires in the spread-apart position, wherein the spacers are preferably arranged equally spaced from each other in longitudinal direction.

Another feature of the invention provides that, after the spacer elements have been mounted, the individual wires are again moved toward each other in radial direction to assume the original spacing.

Since the individual wires of the strand are spread apart in a continuous process under elastic deformation and are subsequently moved together again, the strand is prevented by the spacer elements mounted during spreading from following its natural tendency of again assuming the original position; when the wires are moved toward each other after spreading, the outer wires rest from the outside against the inserted spacer element. The spacer element has geometrically precisely defined dimensions and thus ensures, because of its dimensions, a predetermined outer diameter of the expanded sections. In this manner, the size of the expanded

sections can be precisely defined as required by the placing conditions and the necessary composite action.

The concept of fixing an expanded section of a strand by means of a spacer element placed between the strand wires is already known in connection with an anchoring system for a tensioning member (FR-A 1 551 162). However, in this system, the expanded section is at the end of the strand, so that, for mounting the spacer element, the individual wires are spread apart manually, the spacer element is inserted, and the wires are subsequently again manually moved together.

When using the method according to the present invention, it is possible to mount the spacer elements in a continuous procedure independently of the length of the respective strand and independently of whether the expanded sections are to be produced over the entire length of the strand or only a portion thereof.

The arrangement according to the present invention for carrying out the above-described method includes a rotatably mounted disc with a central opening for passing therethrough the central wire of the strand and with additional outer openings for passing therethrough the outer wires of the strand.

If a strand is pushed, for example, by means of a conventional advancing device, through a spreading disc which is constructed in accordance with the present invention and is rotatably mounted, the spreading disc rotates together with the strand in twisting direction thereof. The diameter and the length of the spread section can be optimized by an appropriate selection of the distance between the openings in the disc for mounting the spacer elements. If the geometric configurations are suitable, the state of the inherent tension of the strand of wires

produces stationary spreading waves, usually consisting of a large main wave and two smaller waves, wherein one of the smaller waves precedes the main wave and the other smaller wave follows the main wave. The spacer elements are preferably mounted in the area of greatest expansion, *i.e.*, in the area of the main wave and immediately following the spreading disc seen in advancing direction.

Spreading of the strand wires and the simultaneous mounting of the spacer elements can basically be carried out continuously or intermittently. The method is influenced by the selection of locations in the area of spreading where the spacer elements are to be mounted. It is also possible to mount two or more spreading discs, one behind the other, in order to extend the spreading of the strand over a greater length.

Steel wire strands to be used in this connection usually consist of seven wires, *i.e.*, a central wire and six other wires. When the strands have seven wires, the rotatably mounted spreading disc has seven openings, *i.e.*, a central opening for the central wire and six outer openings for the outer wires.

Finally, the spacer element for use in the method according to the present invention is a radially symmetrical body which has, on its outer circumference, a number of contact surfaces which correspond to the number of outer individual wires of the strand, and an opening in the central portion for passing the central wire therethrough.

Various types of configurations of the spacer element are possible. Mechanical spacer elements must have a central opening through which the central wire can be passed. Particularly simple is the use of a polygonal body, particularly a hexagonal nut, which forms contact surfaces for the outer wires at the sides of the polygonal shape and has a central bore

for the central wire. By using suitable advancing devices, spacer elements required for the length of an anchor element can be made available in the area where the strand is to be spread apart, and the central wire can be inserted at this location in the central opening, so that it is sufficient to release the spacer elements in the appropriate longitudinal spacings for taking the spacer elements along with the strand. However, it is also possible to have a spacer element in which the central opening is open toward the circumference by means of a slot, so that the spacer element can be placed in the area of the spread-apart section from the top or from the side, manually or by means of a device which rotates together with the spreading disc.

In accordance with a preferred feature of the present invention, the spacer element is made from an essentially U-shaped blank which is placed on the central wire of the strand and is then subjected to a pressing tool in such a way that the spacer element entirely surrounds the central wire.

On the other hand, it is also possible to use a quickly hardening material as the spacer element, wherein the quickly hardening material is introduced into the appropriate locations between the individual wires of the strand and fixes the wires of the strand in the spread-apart form after hardening.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of the disclosure. For a better understanding of the invention, its operating advantages, and specific objects attained by its use, reference should be had to the drawing and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

In the drawings:

Fig. 1a is a side view of an anchor element manufactured in accordance with the present invention;

Fig. 1b is a cross-sectional view of the anchor element of Fig. 1a;

Fig. 2a is a schematic illustration of an arrangement for carrying out the method of the present invention;

Fig. 2b is a schematic illustration of another arrangement for carrying out the method of the present invention;

Fig. 2c is a sectional view showing spread-apart wires between spreading discs;

Fig. 2d is a schematic illustration showing a spreading procedure in accordance with the present invention;

Fig. 2e is a sectional view showing a central wire of the strand guided outside of the outer wires of the strand;

Fig. 2f is a schematic illustration of another spreading procedure;

Fig. 3 is an illustration, on a larger scale, of a detail of the arrangement of Fig. 2a, showing the spreading procedure and the mounting of a mechanical spacer element.

Fig. 4 is a cross-sectional view of a spreading disc taken along sectional line IV-IV in Fig. 3;

Fig. 5 is a cross-sectional view of a spreading disc taken along sectional line V-V in Fig. 3;

Fig. 6 is a schematic view of a guiding device for the strand with expanded sections;

Figs. 7a-7b show different embodiments of the spacer element;

Fig. 8 is a side view of another embodiment of the anchor element manufactured in accordance with the present invention;

Fig. 9 is an illustration, on a larger scale, showing the spreading procedure of the strand and the introduction of a spacer element of hardening material;

Fig. 10 is a cross-sectional view of another embodiment of the spreading disc taken along sectional line X-X in Fig. 9;

Fig. 11 is a sectional view of the spacer element taken along sectional line XI-XI in Fig. 9;

Fig. 12 is a schematic illustration of another embodiment of the spacer element shown in three different phases of its manufacture; and

Figs. 13a-13d show another embodiment of the spacer element according to the present invention.

Fig. 1a of the drawing is a schematic side view of an anchor element 1 suitable as a rock anchor as it is to be manufactured by the method according to the present invention. The anchor element 1 is made from a steel wire strand 2 which, in the simplest case, is composed of seven steel wires 3 which include six outer wires 3b grouped around a central wire 3a, as illustrated in Fig. 1b.

The strand 2 has expanded sections 4 which are arranged preferably at equal spacings a from each other. Spacer elements 5 are arranged in the expanded sections 4 for maintaining the outer wires 3b in the spread-apart state. For using the element as a rock bolt, the strand 2 is provided at one end thereof with an anchoring system which, in the illustrated embodiment, is a wedge-type anchoring system. The anchoring system includes an anchoring body 7 with an annular wedge 8 which rests against an anchor plate 6. When the anchor element 1 is used as a rock bolt and is inserted into a bore hole, and the rock anchor is secured in the bore hole by forcing hardening material into the bore hole, the anchor plate 6 rests against a working surface, not illustrated.

The method according to the present invention for manufacturing an anchor element can best be described with the aid of Fig. 2a. The strand 2 is pulled from a roll 9 and moved in axial direction by means of an advancing device 11 in the advancing direction indicated by arrows 10. The strand 2 is then passed through a rotatably mounted spreading disc 12 in which the individual wires 3 of the strand 2 are spread apart for producing the expanded sections 4. As the strand 2 is passed through the spreading disc 12, the spreading disc 2 rotates corresponding to the pitch of the twisted wires 3b around the central wire 3a. During these

movements of passing the strand 2 through the spreading disc 12, stationary waves are formed in the strand. The waves include a main wave in the region of the maximum expansion and a smaller wave 14 in front of the main wave and another smaller wave 15 following the main wave. In accordance with the present invention, the spacer elements 5 are preferably arranged in the region of the maximum spreading, *i.e.*, in the region of the main wave 13 immediately following the spreading disc 12. The individual wires 3 are subsequently combined again and, after being advanced further, reach a cutting device 16 which cuts the individual anchor elements 11 to length.

As mentioned previously, it is also possible to mount two or more spreading discs, one behind the other, in order to extend the spreading of the strand over a greater length. In the embodiment illustrated in Fig. 2b, three spreading discs 12 are provided. Fig. 2c shows the outer wires 3b as spread apart from the central wire 3a.

When the outer wires 3b are expanded, differences in length occur between the outer wires 3b and the central wire 3a. In the embodiment illustrated in Fig. 2d of the drawing, these differences in length can be compensated for by manually guiding the central wire 3a following the first spreading disc 12 in advancing direction of the strand essentially along a straight line outside of the outer wires 6b. At the second spreading disc 12 in advancing direction of the strand, the central wire 3a is again returned to the center between the outer wires 6b. The cross-sectional view of Fig. 2e shows the central wire 3a outside of the circle formed by the six outer wires 6b. Finally, Fig. 2f shows that, following the first spreading disc 12, the central wire 3a can also be guided spirally around the outer wires 3b.

Figs. 3-7 of the drawing show how the spacer elements 5 can be mounted in the region of the spread-apart sections.

Fig. 3 shows a detail of Fig. 2a with the spreading disc 12 and the main wave 13. As shown in Fig. 4, the spreading disc 12 can be rotatably mounted, for example, by means of several rollers 17 between which the spreading disc 12 is supported and on which the circumference of the spreading disc 12 rolls off. The spreading disc 12 has a number of openings 18 through which the strand wires 3 are passed. Specifically, the central wire 3a is passed through the central opening 18a, and the six outer wires 3b are passed through the outer openings 18b which are arranged on a circle.

The wires 3 are manually inserted into the openings 18. When the strand 2 is pushed through the spreading disc 12 in the above-described manner by means of the force produced by the advancing device 11, the spreading disc 12 rotates as determined by the direction of twisting of the wires of the strand 2.

As illustrated in Fig. 3 of the drawing, a prefabricated spacer element 5 is mounted between the spread-apart wires. As illustrated in Fig. 5, the spacer element 5 may be a flat disc 19 which has a central recess 20 for the central wire 3a and flat recesses 21 distributed over the circumference for the outer wires 3b. The central recess 20 is connected to a mounting slot 22 by means of which the disc 19 can be placed on the central wire 3a. As indicated by broken lines in Fig. 3, the disc 19 can be mounted by inserting it in horizontal position between two wires 3b into the spread-apart portion of the wires, by turning the disc 19 about 90° and placing it with the slot 22 over the central wire 3a, so that the central wire 3a is received in the central recess 20, as can be seen in Fig. 5. If the strand 2 is advanced slowly,

this manipulation can be carried out continuously as the strand is advanced. However, it is also possible to stop the advance of the strand for a short period and to insert the disc 19.

An even simpler form of the spacer element 5 is a hexagonal nut 23, 23′, as illustrated in Figs. 7a-7b. A hexagonal nut 23 can be purchased very inexpensively, and the sides 24 of the hexagonal nut represent six contact surfaces for the six outer wires 3b of the strand 2. The nut 23 also already has the central bore 25. If the hexagonal nut is manufactured specifically for use as a spacer element for the method of the present invention, the nut 23 does not have to be provided with a thread in the central bore.

As illustrated in Fig. 7a, the hexagonal nut 23 can also be provided with a slot 26 extending to the central bore 25. The slot may also extend conically to produce a keyhole shape with a narrow portion having a middle slightly smaller than the diameter of the central wire 3a for preventing the central wire 3a from again sliding out of the central bore 25. However, as shown in Fig. 7b, the hexagonal nut 23′ can also be used without the slot 26.

The use of spacer elements 5 in the form of hexagonal nuts 23-23′ provides the advantage that several such nuts can be guided in a cartridge through two oppositely located parallel sides, that the nuts can be stored in an orderly fashion and can be positioned automatically. This can be done either by means of a stationary device or by means of a device which rotates with the spreading disc 12 in such a way that one spacer element is always released. If closed spacer elements are used, such as the nut 23 of Fig. 7b, all spacers required for an anchor element must be made available in the region of the main wave 13 of the spread-apart wires, and the spacer elements must be released successively. This can also be carried out

either by means of devices which act from the outside and reach into a space between two outer wires 3b or by means of devices which rotate together with the spreading disc.

For the further guidance of the strand 2, which has been provided with expanded sections 4, guiding devices 28 can be provided, which are illustrated in detail in Fig. 6. The guiding device 28 includes a number of rollers 29 or friction bearings which are arranged in such a way that they form a circular passage 30. The individual rollers 29 are resiliently mounted by means of spring elements 31, so that the rollers 29 can follow the changing diameters of the strand 2.

Another embodiment of an anchor element 1′ is illustrated in Fig. 8. In this anchor element 1′, the individual strand wires 3b are not completely pushed together to the original diameter of the strand 2 after the spacer elements 5 have been inserted. A configuration of this type can be obtained, especially when nodes of a hardening material are used as spacer elements 5. The manner of applying the nodes is explained with the aid of Figs. 8-10.

Similarly to Fig. 3, Fig. 8 shows a section of Fig. 2 with the spreading disc 12′. The spreading disc 12′ has essentially the same configuration and is mounted in the same manner as the spreading disc 12, as shown in Fig. 4. Only the central opening 18a′ for the central wire 3a has the form of a slot in order to permit undulating movements of the central wire 3a. Similar to the mounting of a disc-shaped spacer element 19 in the region of the main wave 13, as shown in Fig. 3, a node 33 of a quickly hardening material, for example, a reaction resin, is applied at this location by means of a nozzle 32, as shown in Fig. 8, wherein the node 33 surrounds the individual wires 3a, 3b and fixes the wires in the spread-apart position, as can be seen in Fig. 11.

As mentioned above, when the outer wires 3b are expanded, differences in length occur between the outer wires 3b and the central wire 3a in the final state of the expanded sections. In the method described in connection with Fig. 3 of the drawing, these differences in length can be compensated by longitudinally displacing the central wire relative to the outer wires. However, this compensation cannot be carried out when the individual wires 3 are fixed together at certain points by the hardening material. By providing the central opening of the spacer member as a slot 18a', it is possible for the central wire 3a to extend in an undulated manner between the nodes 33 in order to effect a compensation of any differences in length. However, this type of configuration can also be used when the length compensation is very difficult or cannot be carried out at all for other reasons.

Another possibility for compensating length differences between the central wire and the outer wires, which are shortened in axial direction because of the expansions, is to sever the central wire 3a at axially spaced apart locations or to cut out individual pieces from the central wire at certain locations. However, in order to make the central wire 3a accessible, it is necessary to spread out the outer wires 3b at a location in front of the spreading location for mounting the spacer elements 5.

For example, it is possible to arrange, in front of the advancing device 11 showing Fig. 2, one spreading disc or even two spaced-apart spreading discs for spreading out the outer wires, so that the central wire can be reached by a cutting device and the central wire can be severed or pieces of the central wire can be cut out. After the spreading, the individual wires are always moved back together again to the original spacing, so that an axial advancing force is again applied to the strand by the advancing device 11 before the strand is again guided

through one spreading disc 12 or also two spaced-apart spreading discs, between which the spacer elements 5 are mounted.

If the spacer elements 5 are mounted between two spreading discs 12, the spreading disc located in front in advancing direction must have a central opening which has such a size that the spacer element 5 slid onto the central wire 3 can be passed through this central opening. To make it easier to insert the spacer elements 5, it is also possible to arrange the openings 18b for the outer wires 3b in the spreading disc 12 at different distances from each other, so that at least one greater gap exists between two openings. After the expansion has been carried out, the outer wires 3b are again guided toward each other, so that the continuous movement of the anchor element and the coherence thereof are not impaired.

Another embodiment of a spacer element 5 is illustrated in Fig. 12 of the drawing. When the strand is advanced, the twisted strand wires 3 not only result in a rotary movement of the spreading disc 12, as is apparent from Fig. 3, but the outer wires 3b successively travel past the plane of the disc 12 following the so-called spin of the strand, *i.e.*, the manner in which the wires are twisted. In Fig. 12, the outer wires 3b are designated by A, B, C, D, E, and F. The three views of Fig. 12 show three positions of the outer wires 3 offset by 120° corresponding to a third of the spin S/3 of the strand. It is not possible to insert in each of these positions a flat spacer member 35 from a side, as indicated by arrows 34. The spacer member 35 rests on three lower wires and secures two upper wires in an upper clamp-like recess 36. Thus, to the spacer member 35, which secures the two upper wires A, B inserted in accordance with Fig. 12a, are added another spacer member 35, offset by 120° according to Fig. 12b, and a third spacer 35 in accordance with Fig. 12c, so that an expanded section is formed in the final

state by the three spacer members 35 which have been inserted offset by 120° relative to each other. This embodiment of the spacer member has the advantage that the uniformly constructed elements can be positioned at the same location by a simple horizontal displacement, *i.e.*, by a manipulation which can be easily automated.

Another embodiment of the spacer element is illustrated in Figs. 13a-13d. As shown in Fig. 13a, the spacer element may also be a U-shaped member which is placed over the central wire 3a which has been guided outside of the outer wires 3b. Subsequently, a pressing tool 40 acts on the U-shaped member and presses it into the shape.of the spacer element 5 illustrated in Fig. 13b. The final configuration after the central wire 3a has been returned to the the center between the outer wires 3b is illustrated in Fig. 13c. Of course, the spacer element could also be pressed into a circular shape, as shown in Fig. 13d.

It should be understood that the preferred embodiments and examples described are for illustrative purposes only and are not to be construed as limiting the scope of the present invention which is properly delineated only in the appended claims.

CLAIMS

1. A method of manufacturing an anchor element from a strand of twisted steel wires, the anchor element having at least one expanded section, the wires including a central wire and a plurality of outer wires surrounding the central wire, the method comprising advancing the strand in an axial direction and spreading the outer wires from the central wire by passing the central wire through a central opening of a rotatably mounted spreading disc and passing the outer wires through outer openings of the spreading disc spaced form the central opening, and mounting spacer elements between the wires of the strand for maintaining the wires in a spread-apart position for forming the at least one expanded section.

2. The method according to claim 1, comprising mounting a plurality of spacer elements between the wires of the strand, wherein the spacer elements are spaced axially at equal distances from each other.

3. The method according to claim 1 or claim 2, comprising cutting the strand to a desired length of the anchor element.

4. The method according to any preceding claim, comprising mounting the at least one spacer element between the wires of the strand at a location following the spreading disc in the advancing direction of the strand.

5. The method according to any preceding claim, comprising continously advancing the strand as the at least one spacer element is mounted.

6. The method according to any of claims 1 to 4, comprising intermittently advancing the strand such that the strand is stopped during the mounting of the at least one spacer element.

7. The method according to any preceding claim, comprising moving the outer wires back against the central wire after the at least one spacer element has been mounted.

8. The method according to any of claims 1 to 6, comprising maintaining the outer wires in a spread apart position from the central wire after mounting of the at least one spacer element.

9. The method according to any preceding claim, comprising, prior to spreading of the outer wires from the central wire for forming the at least one expanded section, severing the central wire of the strand at least at one point along a length of the central wire.

10. The method according to claim 9, comprising spreading apart at least two outer wires sufficiently for passing therebetween a cutting tool for severing the central wire.

11. The method according to claim 10, comprising moving the outer wires back against the central wire after spreading the at least two outer wires for severing the central wire and prior to spreading the outer wires from the central wire for mounting the at least one spacer element.

12. The method according to any preceding claim, further comprising passing the central wire

through a central opening of a rotatably mounted second spreading disc and passing the outer wires through outer openings of the second spreading disc, the outer wires being located on a circle in the transverse direction of the strand, and guiding the central wire outside of the circle of the outer wires between the spreading disc and the second spreading disc.

13. The method according to claim 12, comprising guiding the central wire essentially along a straight line between the spreading disc and the second spreading disc.

14. The method according to claim 12, comprising guiding the central wire spirally between the spreading disc and the second spreading disc.

15. The method according to any preceding claim, wherein the step of mounting the spacer elements comprises placing an essentially U-shaped blank on the central wire, and subsequently pressing the U-shaped blank in a pressing tool, such that the blank completely surrounds the central wire.

16. An arrangement for spreading apart individual wires of a strand of twisted steel wires, including a central wire and a plurality of outer wires surrounding the central wire, the arrangement comprising a rotatably mounted spreading disc having a central opening and a plurality of outer openings spaced from the central opening, and means for advancing the strand in axial direction thereof and for passing the central wire through the central opening and the outer wires through the outer openings.

17. The arrangement according to claim 16, wherein the spreading disc has a center, wherein the central opening is a slot having an axis, and wherein the axis of the slot extends through the center of the disc.

18. The arrangement according to claim 16 or claim 17, wherein the central opening and the outer openings have diameters, and wherein the diameter of the central opening is greater than the diameter of the outer openings.

19. The arrangement according to any of claims 16 to 18, wherein the outer openings of the spreading disc are spaced apart from each other at unequal distances.

20. An arrangement for manufacturing an anchor element from a strand of twisted steel wires, including a central wire and a plurality of outer wires surrounding the central wire, the anchor element having at least one expanded section, the arrangement comprising a rotatably mounted spreading disc having a central opening and a plurality of outer openings spaced from the central opening, and means for advancing the strand in axial direction thereof and for passing the central wire through the central opening and the outer wires through the outer openings, means following the spreading disc in advancing direction of the strand for moving the outer wires back toward the central wire between spacer elements, and means for cutting the strand to a predetermined length of the anchor element.

21. A spacer element for maintaining a

plurality of outer wires of a strand of twisted steel wires apart from a central wire of the strand, for forming an expanded section of an anchor element manufactured from the strand, the spacer element comprising a radially symmetrical body having an outer circumference, the circumference defining a plurality of contact surfaces for the outer wires, and a central recess for receiving the central wire.

22. The spacer element according to claim 21, wherein the body is a plane disc.

23. The spacer element according to Claim 21, wherein the body is a double cone-shaped member.

24. The spacer element according to any of claims 21 to 23, wherein the body defines a slot extending between the central recess and the circumference of the body.

25. The spacer element according to claim 24, wherein the central recess and the slot define a keyhole-shaped recess, the keyhole-shaped recess having a transition between the central recess and the slot, the transition having a width, the central wire having a diameter, wherein the width of the transition is slightly smaller than the diameter of the central wire.

26. A spacer element for maintaining a plurality of outer wires of a strand of twisted steel wires apart from a central wire of the strand, for forming an expanded section of an anchor element manufactured from the strand, the spacer element comprising a body of quickly hardening material introduced into the expanded section formed by the

spread apart outer wires in a quantity sufficient for maintaining the outer wires spaced from the central wire by a predetermined distance.

27. The spacer element according to claim 26, wherein the quickly hardening material is a reaction resin.

28. A spacer element for maintaining six outer wires of a strand of twisted steel wires apart from a central wire of the strand, for forming an expanded section of an anchor element manufactured from the strand, the spacer element comprising thee flat, clamp-like members having edges, the members having a size sufficiently small for inserting the members between the spread-apart outer wires, each member support two adjacent outer wires, the edges of each member resting on the outer wires located next to the two adjacent wires supported by the member.

29. The spacer element according to claim 26, wherein the three members are mounted offset relative to each other in axial direction of the strand.

30. A method of manufacturing an anchor element substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

31. An arrangement for spreading apart individual wires of a strand substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

32. An arrangement for manufacturing an anchor element substantially as hereinbefore described with

reference to and as illustrated in the accompanying drawings.

33. A spacer element substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.